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NOTES ON THE GENUS *STHENOPIS* (HEPIALIDAE) IN ALBERTA, CANADA

Additional key words: semivoltine, biennialism.

The nearctic genus *Sthenopis* Packard (Hepialidae) currently contains five species (Davis 1983), of which *S. argenteomaculatus* (Harris), *S. purpurascens* (Packard) and *S. quadriguttatus* (Grote) purportedly occur in Alberta (Bowman 1951). Despite their large size and peculiar habits, little is known about their biology and specimens are rare in collections. The purpose of this note is to report on the adult biology and distribution of the genus in Alberta. *S. argenteomaculatus* does not occur in Alberta, and *S. quadriguttatus* was placed into synonymy with *S. purpurascens* by Nielsen et al. (1999) based on morphological characteristics. Our observations of sympatric populations of *S. purpurascens* and *S. quadriguttatus* color morphs support this view.

Specimens examined and study sites. A total of 96 *Sthenopis* specimens from Alberta and Saskatchewan were examined, from the following sources: Northern Forestry Centre (NFC) (Canadian Forest Service, Edmonton), University of Alberta Strickland Museum (UASM) and the private collections of the authors.

Behavior observations and habitat notes were based on the following Alberta localities: Finnegan Ferry (51°8′N, 112°5′W), 15-July-1985 (DDL); Didsbury (51°40′N, 114°8′W), 23-July-1987 (BCS); 23 km N. of Lac La Biche (54°55′N, 112°05′W), 22-July-1997 (BCS); Rock Island Lake (55°35′N, 113°25′W), 26-July-1997 (BCS); Gregoire Lake Provincial Park (56°35′N, 111°10′W), 24-July-1997 (BCS); 10 km S Cooking Lake (53°21′N, 113°05′W), 28-31-July-1997 (DDL, BCS); Palisades Research Centre, Jasper National Park (52°58′N, 118°04′W) 1030 m, 8-July-1998 (BCS); Redwater Natural Area (53°55′N, 112°57′W), 28-July-1999 (BCS).

Sthenopis argenteomaculatus occurs from Québec to New England, and westward to Minnesota and Ontario (Strecker 1893, Forbes 1923, Riotte 1992, Handfield 1999). It is also reported from Alberta (Bowman 1951) and Saskatchewan (Hooper 1981), and Ives and Wong (1988) state this species occurs throughout the prairie provinces. However, this species has often been confused with *Sthenopis purpurascens* (Forbes 1923), and specimens labeled as *S. argenteomaculatus* in the Bowman collection (UASM) and the NFC are variants of *S. purpurascens*. Hooper (1981) and Ives and Wong (1988) provide a figure of a specimen identified as *S. argenteomaculatus*. Comparisons with illustrations of *S. argenteomaculatus* from eastern North America (Solomon 1995, Handfield 1999) and specimens from Nova Scotia (BCS) reveal that the figures in Hooper (1981) and Ives and Wong (1988) are actually *S. purpurascens*. Furthermore, the peak flight period of *S. argenteomaculatus* is in mid- to late June, whereas *S. purpurascens* has a much later peak, from mid-July to August (Handfield 1999). Hooper (1981) states that in Saskatchewan, "adults [of the Hepialidae] emerge from mid-July to September". Based on this, previous reports of *S. argenteomaculatus* for Alberta and Saskatchewan should be referred to *S. purpurascens*.

Sthenopis purpurascens ranges from British Columbia and the Northwest Territories east to Labrador and New York (Grote 1864, Forbes 1923, Prentice 1965, Handfield 1999), and as far south as the White Mountains of Arizona in the west (D. Wagner pers. comm.). In Alberta, this species is most common throughout the boreal mixed wood and aspen parkland ecoregions, and occurs locally in the mountain and prairie regions. The boreal forest localities include a range of habitats; the Cooking Lake site consists of mature trembling aspen (*Populus tremuloides*) woods, with an understory of beaked hazelnut, *Corylus cornuta*, and wild red raspberry, *Rubus idaeus*. The Redwater site is sandy, open jack pine (*Pinus banksiana*) forest, interspersed with stands of trembling aspen and paper birch (*Betula papyrifera*). Green alder (*Alnus crispa*) is the most common understory shrub. The Palisades Research Centre locality is within the montane ecoregion (Strong & Leggat 1992), and consists of dry, open meadows with stands of trembling aspen and lodgepole pine (*Pinus contorta*). *S. pupurascens* also occurs in riparian balsam poplar (*Populus balsamifera*) groves in the mixed grass prairie ecoregion (Finnegan Ferry site); populations here are likely restricted to riparian areas, since the larvae bore in the roots of poplar and aspen, *Populus* spp. (Prentice 1965, Gross & Syme 1981). It appears that *S. purpurascens* occurs throughout most of the province where suitable host plants occur.

The light color form (formerly *Sthenopis quadriguttatus*) occured together with typical *S. purpurascens* at all 1997 localities, with the exception of Gregoire Lake P.P. The fact that both phenotypes were collected together at several sites suggests that the habitat requirements and phenology of the two phenotypes are very similar, supporting the synonomy of *quadriguttatus* into *purpurascens* proposed by Nielsen et al. (1999). Furthermore, the two phenotypes are almost identical in wing pattern, shape and size; only the ground color varies. Similar morphs (with salmon or brown ground color) occur in *Hepialus behrensi* (Stretch) (D. Wagner pers. comm.) and *Gazorycta noviganna* (Barnes & Benjamin) (C. Schmidt unpubl. data).

The relative frequency of phenotypes in the specimens examined is unbiased in males (17 "*quadriguttatus*" : 15 "*purpurascens*"; X^2 = 0.125, $0.50 < p < 0.75$) but a significantly higher proportion of females exhibited the *quadriguttatus* phenotype (46:18; X^2 = 12.25, $p < 0.001$). Assuming both phenotypes are equally likely to be attracted to light, it appears that the mechanisms determining phenotype may be sex-linked.

Flight observations. Male and female *Sthenopis purpurascens* were observed flying at dusk; nightly flight activity was very brief, occurring between 2210 h and 2300 h (Cooking Lake and Redwater), with sunset at 2135 h (MST). Crepuscular flight activity is characteristic of hepialids, including other members of the genus *Sthenopis* (Winn 1909, McCabe & Wagner 1989, Wagner & Rosovsky 1991). Females displayed a nearly stationary, hovering flight, usually less than one meter above the shrub understory. One female was observed ovipositing between 2245 h and 2300 h, while exhibiting this type of behavior (Redwater site). Eggs were broadcast over vegetation consisting of low, herbaceous plants and scattered aspen saplings and alder shrubs. Although it was difficult to determine the rate at which eggs were dropped, captive females can lay approximately 1.5 eggs per second.

Males were only rarely observed flying, and flight became rapid and erratic when disturbed. Members of the genus *Sthenopis* are unusual in that males possess long-range sex attractants, whereas this strategy is usually characteristic of female Lepidoptera (Mallet 1984, Wagner & Rosovsky 1991). Two types of courtship behaviour have been observed in *Sthenopis*: Males of *S. thule* and *S. argenteomaculatus* form mating swarms (leks) which females enter to mate (Winn 1909, Covell 1981), and male *S. auratus* are sessile and call for females, fanning their wings over the scent tufts (McCabe & Wagner 1989). These two mating strategies may be density-dependent, with male lekking behaviour occurring at higher densities (Wagner & Rosovksy 1991). Since our observations of *S. purpurascens* failed to turn up males exhibiting courtship behavior, it remains unclear which courtship type this species exhibits.

Female *S. purpurascens* are more likely to be collected, since there is a high female bias in examined specimens (64 ♀ : 32 ♂) and sex ratios are unbiased in the Hepialidae (Wagner & Rosovsky 1991). This is likely due to the fact that females have a longer nightly flight period during which oviposition occurs, while males are only active for a brief time period (D. Wagner pers. comm.). In hepialids where females release sex attractants, collections are often male-biased (Wagner & Rosovsky 1991).

Phenology. Data labels of examined specimens range from July 5th to August 14th, and indicate the peak flight occurs during the last two weeks of July. Larvae of *S. purpurascens* likely take two years to develop (Vallée & Béique 1979); this can result in adults being much more common in alternating years. Out of the 16 years represented by the specimens examined (between 1931 and 1999), only five are even-numbered years; this phenomenon has also been observed in other hepialids (Wagner et al. 1989). It is thought that biennial species remain synchronous through complex interactions with predators and parasitoids, abiotic catastrophes, and plant defense mechanisms (Mikkola & Kononenko 1989, Mikkola 1976, Wipking & Mengelkoch 1994). The odd-year biennialism in *S. purpurascens* is synchronous with other biennial Lepidoptera species in the west; many of the Yukon species of *Boloria* (Nymphalidae), *Erebia*, *Oeneis* (Satyridae) and *Xestia* (Noctuidae) have a greater adult abundance in odd-numbered years (Lafontaine & Wood 1997). This odd-year zone extends from Hudson Bay westward to Fennoscandia (Lafontaine & Wood 1997), but it is not known what causes synchrony between such a wide range of taxa.

Further research is needed to determine the courtship and mating behavior of *S. purpurascens*, whether or not density-dependent lekking occurs, if there is a pre-dawn flight period, and to verify if both phenotypes interbreed.

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TWO LARGE TROPICAL MOTHS (*THYSANIA ZENOBIA* (NOCTUIDAE) AND *COCYTIUS ANTAEUS* (SPHINGIDAE)) COLONIZE THE GALAPAGOS ISLANDS

Additional key words: light traps, island colonization.

The arrival and establishment of a species on an isolated oceanic island is a relatively rare event. The likelihood of colonization depends on a variety of features of the species, including dispersal ability, availability of food (hostplants or prey) and ability to reproduce. In this note, I discuss two recent Galapagos records of tropical moths in the context of island colonization.

Thysania zenobia (Cramer) is a tropical migratory species which has been occasionally collected in the Holarctic region (Ferguson et al. 1991). Its life history is unknown, but legumes are considered probable larval foodplants (Covell 1984). Between 20 and 25 April 1996, three fresh males were collected in a Mercury vapor light trap near Asilo de la Paz, Floreana Island, at 338 m elevation. The trap was located at the border of the agricultural zone and native forest. In March 1997, I collected another specimen in a forest of the endemic composite, *Scalesia pedunculata* Hook at Los Gemelos, Santa Cruz island, at 580 m elevation, feeding in a bait trap (mixture of rotting fruit). The fresh condition of these specimens suggested that they were from a population extant on the island, rather than migrant. These Galapagos specimens are identical in wing pattern and size to series from continental United States reported by Covell (1984).

Cocytius antaeus (Drury) is one of the larger hawk-moths of the Neotropical region. Members of the Annonaceae have been reported as hostplants (Kimball 1965). Dyar (1901) and Matteson (1933) described its life cycle. I collected two specimens on Santa Cruz Island. On 26 May 1996, I captured a fresh female in a mercury vapor lamp trap at Media Luna (580 m elevation), the fresh condition again suggesting an existing population. This habitat is a mature forest of the endemic *Miconia robinsoniana* Cong. (Melastomataceae), native ferns and the introduced tree *Cinchona succirubra* Klotzsch (Rubiaceae). One month later, one worn male was collected by Godfrey Merlen at an outdoor fluorescent light at the Charles Darwin Research Station (sea level).

Although I have never collected larvae of this species, farmers in Santa Cruz and San Cristobal Islands have reported the presence of "voracious green hornworms" feeding on leaves and branches of the introduced custard apple (*Annona cherimola* Mill). It is likely that these reports refer to *C. antaeus*, because no other Galapagos sphingids feed on members of the Annonaceae.

The lack of specimens of these two moth species in previous lepidopteran surveys of the islands suggests that these are relatively recent additions to the fauna. Hayes (1975) did not report their presence in the archipelago but his species list was based on specimens collected by early expeditions with less efficient light traps (kerosene lamps) and collections made by amateur entomologists. Recently (1989 and 1992), Bernard Landry carried out an intensive Lepidoptera survey on the islands but he never collected the species (Landry pers. comm.). However, it is also possible that the absence of these species from earlier collections is due to flight time. I trapped both species late at night (2300 h to 2400 h) and few collections have been made during these hours by earlier collectors.

Several features of the biology of these two species may have contributed to their ability to reach the Galapagos. Both, *C. antaeus* and *T. zenobia* have a history of long dispersal events by active flying to new areas, including oceanic islands (Ferguson et al. 1991, Schreiber 1978). The occurrence of many species of Annonaceae, all of which were introduced by humans in the present century (Lawesson et al. 1987), has probably favored the establishment of *C. antaeus*.

Although the hostplant of *T. zenobia* is unknown legumes are a likely candidate (Covell 1984). There are many species of legumes on the Galapagos islands, including native and endemic species, and one of these could provide a suitable hostplant.

I suggest that many of the macrolepidoptera that have colonized the Galapagos arrived by natural means and not as a direct result of human activity. However, their establishment has been facilitated by the increase in the number of introduced plant species, deforestation and other human-related activities.

Voucher specimens have been deposited in the entomological collection of the Charles Darwin Research Station Museum on Isla Santa Cruz, Galapagos.

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